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FILED UNDER SEAL

UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN FRANCISCO DIVISION

HUAWEI TECHNOLOGIES CO., LTD., HUAWEI DEVICE USA, INC., and HUAWEI TECHNOLOGIES USA, INC.,

Plaintiff(s)/Counterclaim Defendants,

vs.

SAMSUNG ELECTRONICS CO., LTD, SAMSUNG ELECTRONICS AMERICA, INC.,

Defendants / Counterclaim-Plaintiffs,

and

SAMSUNG RESEARCH AMERICA, INC.,

Defendant,

v.

HISILICON TECHNOLOGIES CO., LTD.,

Counterclaim-Defendant.

Case Number: 3:16-cv-2787-WHO

CONTAINS "HIGHLY CONFIDENTIAL – ATTORNEYS' EYES ONLY" INFORMATION THAT IS SUBJECT TO THE COURT'S PROTECTIVE ORDER

EXPERT REPORT OF DR. ROBERT AKL, D.SC. REGARDING INFRINGEMENT OF UNITED STATES PATENT NO. 8,885,587

Executed on this April 27, 2018, in Denton, Texas.

By 

Dr. Robert Akl, D.Sc.

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I. INTRODUCTION

1. My name is Robert Akl, and I have been retained as a technical expert by counsel for Plaintiffs Huawei Technologies Co., Ltd., Huawei Device USA, Inc., Huawei Technologies USA, Inc., and HiSilicon Technologies Co., Ltd. (collectively "Huawei") to provide expert opinion in the patent infringement lawsuit filed against Defendants Samsung Electronics Co., Ltd., Samsung Electronics America, Inc., and Samsung Research America, Inc. ("Samsung") (collectively "Defendants") in the Northern District of California before the Honorable William H. Orrick, Case No. 3:16-cv-2787-WHO.

2. I understand that Huawei asserts that implementations of particular LTE and 3GPP telecommunications standards necessarily infringe Claims 3 and 9 of U.S. Patent No. 8,885,587 ("the '587 Patent"). Attached to my report is Exhibit A, with copies of the exemplary sections from the LTE standards that require implementations to infringe the '587 Patent ("the LTE-A Standards.") I also understand that Huawei accuses particular Samsung products compliant with these standards of infringing the '587 Patent. Attached to my report is Exhibit B, listing the Samsung user equipment that infringes the '587 Patent ("the Accused Devices.").

3. In this report, I set forth my opinions explaining that implementations of the LTE-A Standards necessarily infringe Claims 3 and 9. I also set forth my opinions that the Accused Devices implement the LTE-A Standards to infringe Claims 3 and 9. This report contains a statement of the bases and reasons for my opinions. If called as a witness, I will testify to the following.

II. QUALIFICATIONS AND PROFESSIONAL EXPERIENCE

4. I am an expert in the field of wireless communications. I have studied, taught, practiced, and researched in the field of wireless communications for over twenty years. I have

which was filed on June 2, 2012, is a continuation of PCT patent application PCT/CN2010/079423. (HW_Samsung_00119046-065). I agree with Huawei that the '587 Patent is essential to the LTE standard because, as explained above, my analysis shows that compliance with the standard requires practicing at least claims 3 and 9 of the '587 patent.

D. Alternatives To The Solution Claimed In The '587 Patent

296. I understand that carrier aggregation was a major subject of debate and discussion at 3GPP meetings. *See, e.g.*, X. Chen Exhibit 1209. Other major telecommunication entities came up with their own solutions, which were ultimately judged inferior to Mr. Chen's. For example, at a November 2009 3GPP meeting, the Chinese Academy of Telecommunications Technology ("CATT") submitted proposal R1-094545, offering three potential solutions for addressing ACK/NACK feedback in the context of carrier aggregation. (SAMSUNG-HNDCA-000014964 – SAMSUNG-HNDCA-000014966). All of these solutions had substantial drawbacks, and none were adopted by the 3GPP standard for incorporation into LTE-A.

297. For example, on CATT's alternative 1, each uplink component carrier fully reserves dynamic ACK/NACK resources for all DL CCs. "Fully" reserving these resources means that the number of reserved ACK/NACK resources for implicit mapping is equal to number of CCEs. Therefore, for *N* downlink component carriers, the dynamic ACK/NACK resource overhead is *N* times that for LTE Release 8 on each UL CC using this proposal. Such a high resource overhead will impact the throughput of UL data transmission, and the large region of reserved resources corresponding to all downlink component carriers is a waste of resources in situtations when there are not so many downlink-heavy asymmetric UEs. Considering the efficiency of dynamic ACK/NACK resource reservation, having every uplink component carrier reserve full PUCCH resources for all downlink component carriers is not a viable alternative.

298. CATT's alternative 2 suffers in the first instance from a vague description. It appears to suggest that each uplink component carrier fully reserves dynamic ACK/NACK resources for "linked" downlink component carrier, based on some system-specific DL/UL linkage established in advance. To support UEs with asymmetric carrier aggregation, this proposal suggests that additional ACK/NACK resources are semi-statically assigned in a UE-specific way for "unlinked" component carriers. This semi-static assignment does not provide the flexibility of Huawei's solution and does not consider the use of ARI in the DCI.

299. CATT alternative 3 provides a configurable ACK/NACK "resource region" that can be reserved for each un-linked DL CC. This resource region means that the number of reserved ACK/NACK resources for implicit mapping may be less than the number of CCEs and is configurable. However, this proposal still requires a fair amount of ACK/NACK overhead, and would require designing new CCE to ACK/NACK mapping equation(s), and could create possible ACK/NACK collisions and scheduling constraints.

300. Ultimately, the conclusion of R1-094545 proposes that CATT alternative 2 and alternative 3 are used together to handle different number of DL heavy UEs (i.e. UEs with heavy DL traffic and hence requires DL carrier aggregation.) This would result in a non-uniform solution in different scenarios and increasing the complexity. Besides, CATT's proposal would only work with certain PUCCH formats, because it relies on uplink ACK/NACK resources being implicitly mapped from the PDCCH CCE index, which may be suitable for ACK/NACK feedback based on PUCCH format 1a/1b, but no discussion of new or other for PUCCH formats (such as format 2 or format 3) is provided.

301. As another example, at the 3GPP TSG RAN WG1 meeting #60bis, held in Beijing, China in April of 2010, Samsung advanced proposal **R1-102171**, titled "PUCCH

HARQ-ACK Resource Indexing for DL CA." This proposal recognized the importance of "avoid[ing] a large increase in the HARQ-ACK overhead." R1-102171 at 1. However, this proposal suffers from a number of deficiencies that are not present in Huawei's invention. As an initial matter, Samsung's proposal would only work with certain PUCCH formats, because it relies on uplink ACK/NACK resources being implicitly mapped from the PDCCH CCE index, which may be suitable for ACK/NACK feedback based on PUCCH format 1a/1b, but no discussion of new or other PUCCH formats (such as format 2 or format 3) is provided.

302. Samsung provides two alternatives in its proposal, each flawed. Samsung's first alternative involves introducing a HARQ-ACK Resource Index (HRI) Information Element (IE) and DL SCC specific offsets signaled by the higher layers to avoid resource collisions. *Id.* at 3. This necessarily creates additional, unnecessary signaling overhead and message format changes by introducing new information elements. Moreover, it suggests that additional scheduling restrictions are being placed on the eNodeB when scheduling the initial CCE for PDCCH transmission to avoid such collisions. Samsung then goes on to propose a second alternative that would not require the introduction of HRI, but would instead required adding a "DAI" counter field in the DCI for LTE FDD, which would increase the DCI design complexity and length, degrading PDCCH reliability, and would affect backwards compatibility for LTE FDD (while TDD already contained a DAI field, FDD would need to be changed and FDD is the main transmission technology that is used in North America). For at least these reasons, Samsung's proposal is not a feasible alternative to the solution proposed by Huawei.

303. At the 3GPP TSG RAN WG1 Meeting #58bis in Miyazaki, Japan in October of 2009 Ericsson provided proposal **R1-094273** related to this ACK/NACK feedback in connection with carrier aggregation titled "PUCCH transmission for Carrier Aggregation."

(HW_Samsung_00247497-499). In this document, Ericsson proposed that all ACK/NACK resources on the uplink be implicitly mapped based on some combination of the downlink component carrier used, the DL PDCCH CCE, the C-RNTI, and "other parameters." R1-094273 at 2. However, because letting all of the UEs "select" the ACK/NACK resource in this fashion could result in collisions/scheduling constraints, the proposal suggests that a "dynamic indicator" could be introduced to help aid in the selection of PUCCH resources.

304. In my opinion, the complexity of implementing an implicit mapping scheme (for which no implementation details were provided) that would require a dynamic indicator to resolve collisions and scheduling conflicts is not a feasible alternative to the elegant solution provided by Huawei's '587 patent, and it is therefore not surprising to me that Ericsson's proposal was not adopted by 3GPP. Indeed, I note that this proposal is really more the statement of a problem than a solution. No description is given of the various "parameters" that should be used for the proposed implicit mapping (nor any specific method of determining the mapping) and no details are given on how to implement the proposed "dynamic indicator." It is therefore my opinion that this proposal does not offer a fully realized solution. In fact, the proposal explicitly notes that "[t]he details on the design of ACK/NACK for multiple assigned DL component carriers should be studied further." *Id.* Besides, Ericsson's proposal would only work with certain PUCCH formats, because it relies on uplink ACK/NACK resources being implicitly mapped from the PDCCH CCE index, which may be suitable for ACK/NACK feedback based on PUCCH format 1a/1b, but no discussion of new or other PUCCH formats (such as format 2 or format 3) is provided.

305. Qualcomm made two proposals relevant to my analysis, both related to using an implicit mapping between a PDCCH CCE index and a PUCCH resource index. R1-094208,

titled "UL HARQ Feedback for Multicarrier Operation" was presented at 3GPP TSG RAN WG1 Meeting #58bis in Miyazaki, Japan in October of 2009. R1-102320, titled "Conveying multiple ACKs on UL in support of CA" was presented at 3GPP TSG RAN WG1 #60bis in Beijing, China in April of 2010. The later proposal largely tracks the content of the earlier proposal, while offering some additional operational details related to feeding back all ACK/NACK feedback on a single carrier. Both proposals set out two alternatives: 1) an implicit mapping scheme where all ACK/NACK feedback for a UE is sent over a single uplink carrier (SC-FDMA UL); and 2) an implicit mapping scheme where ACK/NACK feedback can be sent over the same uplink carrier (Relaxed SC-FDMA). Each of these alternatives has significant shortcomings.

306. The first alternative is flawed because it imposes significant scheduling requirements on the eNodeB. *See, e.g.*, R1-094208 at 2-3 ("it would be up to the scheduler to ensure that no two UEs use conflicting resources for UL ACK transmission.") Various statements in R1-102320 highlight these restrictions:

- "To accommodate more than two information bits, the orthogonal spreading can be either removed or reduced to length two (as opposed to length four in Rel-8)."
- "Thus, a single UE occupies the dimensions (cyclic shift/orthogonal codes) used by multiple UEs in Rel-8."

As these statements demonstrate, this proposal places a heavy burden on the eNodeB to track and resolve possible ACK/NACK resource collisions, especially considering there are complicated rules and restrictions on how to map a PUCCH resource index to a specific cyclic shift and orthogonal codes and on PDCCH search space design.

307. The second alternative allows for ACK/NACK feedback to be sent on multiple parallel PUCCH channels. The multiple parallel PUCCH channels are on a same uplink

component carrier, as shown in Figure 5. However, an important feature of LTE is SC-FDMA, as adopted in LTE Release 8 uplink, which requires that a UE to not transmit on multiple uplink channels simultaneously (the so-called "single carrier property") for a lower PAPR and a longer battery life. SC-FDMA is an important feature of LTE, although it results in a very complicated design when trying to address how to simultaneously transmit multiple types of information, including scheduling request indicators, ACK/NACK, CSI and uplink data. So, any proposal, like this second alternative, that would "break" SC-FDMA," would result in a significant change to LTE, would require extensive 3GPP discussions, and would be heavily disfavored over a solution, like Huawei's, that did not impact this property.

308. There are other drawbacks to this alternative, as well, as discussed in R1-102320: "Note that although this relaxed SC-FDMA operation is appealing from the specification simplicity point of view and because it does not pose any scheduler restrictions at the eNB, it may not be usable all the time because of power limitations at the UE," and "while the motivation for having non-SC-FDMA based solution is subject to a feasibility study (impact on spectral emission mask and spurious emissions) from transmitting multiple PUCCHs." These drawbacks provide additional reasons why this alternative was not adopted and why Huawei's solution is superior.

309. In addition to the proposals referenced above, the specification of the '587 patent itself discusses possible alternatives to the solution it claims. For example at 8:27-33, the specification notes that 2 bits may be added to the DCI. Of course, this would change the format of the DCI, breaking backwards compatibility with existing equipment and requiring expensive software and hardware updates, increase DCI complexity thereby degrading PDCCH reliability, and increase message overhead. Adding additional fields or bits to the DCI was generally

acknowledged as undesirable and Mr. Chen discussed some of the consequences of adding an additional field to the DCI at his deposition. X. Chen Dep. at 213:12-214:5. He further noted that Huawei, along with other companies such as Ericsson, did not approve of proposals in this issue that would introduce additional bits/fields to the DCI. X. Chen Dep. 216:11-217:9.

XIV. OTHER TOPICS

310. I reserve the right to supplement my report in light of any additional fact discovery, opinions by Defendants' experts, and/or trial testimony. I also reserve the right to provide rebuttal opinions and testimony in response to Defendants' experts, and rebuttal testimony in response to any of Defendants' fact witnesses. Further, I reserve the right to use animations, demonstratives, enlargements of actual exhibits, and other information in order to illustrate my opinions.

311. I expect to continue to develop my opinions discussed in this report. I also reserve the right to supplement my opinions based on information obtained from additional discovery or from Defendants' experts, as indicated above.

312. When called upon to do so, I will offer testimony at trial or otherwise regarding these opinions and will offer rebuttal testimony as appropriate throughout the remainder of this proceeding.